

WHAT IS CLAIMED IS:

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1. An image forming apparatus, comprising:
 - a data buffer unit that buffers input binary data, the sub-scan resolution of which is $2/n$ (n : an odd integer greater than or equal to 3) times a sub-scan print resolution;
 - a data transform unit that transforms the input binary data into output multi-level data of the sub-scan print resolution; and
 - a light beam modulation unit that modulates radiant energy of a light beam in accordance with the output multi-level data.

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2. The image forming apparatus as claimed in claim 1, wherein
said light beam modulation unit forms a dot, the barycenter of which lies on a scan line corresponding to the sub-scan input resolution of the

binary image data, by superposing light beams lying on adjacent $(n+1)/2$ scan lines corresponding to the sub-scan print resolution.

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3. The image forming apparatus as claimed in claim 2, wherein

10 said light beam modulation unit adjusts the radiant energy of the light beam lying on one of the adjacent $(n+1)/2$ scan lines on one end, to substantially 1/2 times the radiant energy of the light beams lying on other scan lines.

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4. The image forming apparatus as claimed in claim 1, wherein

20 said light beam modulation unit forms 2 dots, each having the barycenter lying on one of 2 scan lines corresponding to the sub-scan resolution of the binary image data, by selectively superposing 25 light beams on "n" adjacent scan lines separated at a

distance corresponding to the sub-scan print resolution.

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5. The image forming apparatus as claimed in claim 1, wherein

10 said data transform unit transforms the input binary image data of 2 input scan lines into the output multi-level data of "n" output scan lines.

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6. The image forming apparatus as claimed in claim 5, wherein

20 said data transform unit comprises a data transform table that relates the input binary image data of 2 input scan lines to the output multi-level data of "n" output scan lines.

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7. The image forming apparatus as claimed
in claim 5, wherein

 said data transform unit sets the output
 multi-level data of upper $(n-1)/2$ output scan lines
5 equal to the input binary data of an upper input scan
 line, the output multi-level data of lower $(n-1)/2$
 output scan lines equal to the input binary data of a
 lower input scan line, and the output multi-level
 data of a middle output scan line is based on the
10 input binary data of the upper input scan line and
 the input binary data of the lower input scan line.

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8. The image forming apparatus as claimed
in claim 1, wherein

 said data buffer unit buffers input binary
 data, the sub-scan resolution and the main-scan
20 resolution of which are $2/n$ (n : an odd integer
 greater than or equal to 3) times the sub-scan print
 resolution and a main-scan print resolution,
 respectively; and

 said data transform unit transforms the
25 input binary data into output multi-level data of the

sub-scan print resolution and a main-scan print resolution.

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9. The image forming apparatus as claimed in claim 8, wherein

10 said data transform unit transforms the input binary image data of a 2×2 matrix corresponding to 2 pixels in the main scan directions and 2 input scan lines into the output multi-level data of a "n" \times "n" matrix corresponding to "n" pixels in the main scan directions and "n" output scan lines.

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10. The image forming apparatus as claimed 20 in claim 9, wherein

said data transform unit comprises a data transform table that relates the input binary data of a 2×2 matrix corresponding to 2 pixels in the main scan directions and 2 input scan lines into the 25 output multi-level data of the "n" \times "n" matrix

corresponding to "n" pixels in the main scan directions and "n" output scan lines.

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11. The image forming apparatus as claimed in claim 9, wherein

10 said data transform unit divides the "n" x "n" matrix with the middle pixel array and the middle scan line into four " $(n-1)/2$ " x " $(n-1)/2$ " sub-matrixes, and

15 determines the output multi-level data of the four " $(n-1)/2$ " x " $(n-1)/2$ " sub-matrixes based on the corresponding respective input binary data;

20 the output multi-level data of the upper " $(n-1)/2$ " items and the output multi-level data of the lower " $(n-1)/2$ " items in the middle pixel array are based on 2 upper items and 2 lower items, respectively, in the 2x2 matrix;

25 the output multi-level data of the left " $(n-1)/2$ " items and the output multi-level data of the right " $(n-1)/2$ " items in the middle scan line are based on 2 left items and 2 right items, respectively, in the 2x2 matrix; and

the output multi-level data of the cross point of the middle pixel array and the middle scan line are based on 4 items in the 2x2 matrix.

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12. The image forming apparatus as claimed in claim 11, wherein the data transform unit, when
10 determining the output multi-level data of the middle pixel array based on the 2x2 matrix,

shifts the phase of the output multi-level data so that a pulse of the light beam is shifted in the main scan directions toward a pixel that is
15 turned on.

20 13. An image forming apparatus, comprising:
a data buffer unit that buffers input binary data, the sub-scan resolution of which is $2/n$ (n : an odd integer equal to or greater than 3) times a sub-scan print resolution;

25 a data transform unit that transforms the

input binary data into output multi-level data of the
sub-scan print resolution;

a plurality of light sources that radiates
light beams for scanning a photosensitive unit; and

5 a plurality of light beam modulation units
each of which modulates radiant energy of the light
beam radiated by one of said light sources.

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14. The image forming apparatus as claimed
in claim 1, further comprising:

15 a light source that radiates a light beam;
and

a deflection unit that deflects the light
beam radiated by said light source;

wherein

the image forming apparatus forms an image
20 by a raster scanning method.

25 15. The image forming apparatus as claimed

in claim 8, further comprising:

a solid-state scanning unit in which a plurality of light sources is arranged in the main scan directions for forming an image by a solid-state
5 scanning method.

10 16. The image forming apparatus as claimed
in claim 14, wherein

said light beam modulation unit modulates
one of the pulse width of the light beam, the
intensity of the light beam, and both.

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17. An image forming apparatus, comprising:
20 means for buffering input binary data, the
sub-scan resolution of which is $2/n$ (n : an odd
integer equal to or greater than 3) times a sub-scan
print resolution;

means for transforming the input binary
25 data into output multi-level data of the sub-scan

print resolution; and

means for modulating radiant energy of a light beam in accordance with the output multi-level data.

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18. The image forming apparatus as claimed
10 in claim 17, wherein

said means for modulating the radiant energy of the light beam forms a dot, the barycenter of which lies on a scan line corresponding to the sub-scan input resolution of the binary image data, 15 by superposing light beams lying on adjacent $(n+1)/2$ scan lines corresponding to the sub-scan print resolution.

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19. The image forming apparatus as claimed in claim 18, wherein

said means for modulating the radiant energy of the light beam adjusts the radiant energy

of the light beam lying on one of the adjacent
 $(n+1)/2$ scan lines on one end, to substantially 1/2
times the radiant energy of the light beams lying on
other scan lines.

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20. The image forming apparatus as claimed
10 in claim 17, wherein

said means for modulating the radiant
energy of the light beam forms 2 dots, each having
the barycenter lying on one of 2 scan lines
corresponding to the sub-scan resolution of the
15 binary image data, by selectively superposing light
beams on "n" adjacent scan lines separated at a
distance corresponding to the sub-scan print
resolution.

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21. A method of forming an image for an
image forming apparatus, comprising the steps of:

25 buffering input binary data, the sub-scan

resolution of which is $2/n$ (n : an odd integer equal to or greater than 3) times a sub-scan print resolution;

transforming the input binary data into
5 output multi-level data of the sub-scan print resolution;

modulating radiant energy of a light beam in accordance with the output multi-level data; and superposing the light beam on a scan line
10 with the light beam on a adjacent scan line thereby to form a composite light beam, the barycenter thereof being on a scan line of $2/n$ times the sub-scan print resolution.

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22. The method as claimed in claim 21,
wherein the input binary data of 2 scan
20 lines are transformed into the output multi-level data of "n" scan lines.

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23. The image forming apparatus as claimed
in claim 22, wherein the input binary data are
transformed into the output multi-level data of the
sub-scan print resolution with a data transform table.

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24. The method as claimed in claim 22,
10 wherein, in the step of transforming the
input binary data, the output multi-level data of
upper $(n-1)/2$ output scan lines are set equal to the
input binary data of an upper input scan line, the
output multi-level data of lower $(n-1)/2$ output scan
15 lines are set equal to the input binary data of a
lower input scan line, and the output multi-level
data of a middle output scan line are based on the
input binary data of the upper input scan line and
the input binary data of the lower input scan line.

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25. The method as claimed in claim 21,
wherein,

in the step of buffering the input binary data, the input binary data, the sub-scan resolution and the main-scan resolution of which are $2/n$ (n : an odd integer equal to or greater than 3) times the
5 sub-scan print resolution and a main-scan print resolution, respectively, are buffered; and

in the step of transforming the input binary data, the input binary data are transformed into the output multi-level data of the sub-scan
10 print resolution and a main-scan print resolution.

15 26. The method as claimed in claim 25,
wherein
in the step of transforming the input binary data, the input binary image data of a 2×2 matrix corresponding to 2 pixels in the main scan
20 directions and 2 input scan lines are transformed into the output multi-level data of a " n " x " n " matrix corresponding to " n " pixels in the main scan directions and " n " output scan lines.

27. The method as claimed in claim 26,
wherein

in the step of transforming the input
binary data, a data transform table is used that
5 relates the input binary data of the 2x2 matrix
corresponding to 2 pixels in the main scan directions
and 2 input scan lines to the output multi-level data
of the "n" x "n" matrix corresponding to "n" pixels
in the main scan directions and "n" output scan lines.

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28. The method as claimed in claim 26,
15 wherein, in the step of transforming the
input binary data:

the "n" x "n" matrix with the middle pixel
array and the middle scan line is divided into four
"(n-1)/2" x "(n-1)/2" sub-matrixes;

20 the output multi-level data of the four
"(n-1)/2" x "(n-1)/2" sub-matrixes are determined
based on the corresponding respective input binary
data;

25 the output multi-level data of the upper
"(n-1)/2" items and the output multi-level data of

the lower " $(n-1)/2$ " items in the middle pixel array are determined based on 2 upper items and 2 lower items, respectively, in the 2×2 matrix;

the output multi-level data of the left
5 $"(n-1)/2"$ items and the output multi-level data of the right " $(n-1)/2$ " items in the middle scan line are determined based on 2 left items and 2 right items, respectively, in the 2×2 matrix; and

the output multi-level data of the cross
10 point of the middle pixel array and the middle scan line are determined based on 4 items in the 2×2 matrix.

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29. The method as claimed in claim 28,
wherein, in the step of transforming the
input binary data, when the output multi-level data
20 of the middle pixel array based on the 2×2 matrix are determined,

the phase of the output multi-level data is shifted so that a pulse of the light beam is shifted in the main scan directions toward a pixel that is
25 turned on.

30. An image resolution conversion circuit
for an image forming apparatus, comprising:

a data buffer unit that buffers input
5 binary data, the sub-scan resolution of which is $2/n$
(n: an odd integer equal to or greater than 3) times
a sub-scan print resolution;

10 a data transform unit that transforms the
input binary data into output multi-level data of the
sub-scan print resolution; and

a light beam modulation unit that modulates
radiant energy of a light beam in accordance with the
output multi-level data.

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31. The image resolution conversion circuit
as claimed in claim 30, wherein

20 said data transform unit transforms the
input binary image data of 2 input scan lines into
the output multi-level data of "n" output scan lines.

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32. The image resolution conversion circuit
as claimed in claim 31, wherein

 said data transform unit comprises a data
transform table that relates the input binary image
·5 data of 2 input scan lines to the output multi-level
data of "n" output scan lines.

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33. The image resolution conversion circuit
as claimed in claim 32, wherein

 said data transform unit sets the output
multi-level data of upper $(n-1)/2$ output scan lines
15 equal to the input binary data of an upper input scan
line, the output multi-level data of lower $(n-1)/2$
output scan lines equal to the input binary data of a
lower input scan line, and the output multi-level
data of a middle output scan line are based on the
20 input binary data of the upper input scan line and
the input binary data of the lower input scan line.

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34. The image resolution conversion circuit
as claimed in claim 30, wherein

 said data buffer unit buffers input binary
 data, the sub-scan resolution and the main-scan
5 resolution of which are $2/n$ (n : an odd integer equal
 to or greater than 3) times the sub-scan print
 resolution and a main-scan print resolution,
 respectively; and

 said data transform unit transforms the
10 input binary data into output multi-level data of the
 sub-scan print resolution and a main-scan print
 resolution.

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35. The image resolution conversion circuit
as claimed in claim 34, wherein

 said data transform unit transforms the
20 input binary image data of a 2×2 matrix corresponding
 to 2 pixels in the main scan directions and 2 input
 scan lines into the output multi-level data of " n " \times
 " n " matrix corresponding to " n " pixels in the main
 scan directions and " n " output scan lines.

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36. The image resolution conversion circuit
as claimed in claim 35, wherein

5 said data transform unit comprises a data
transform table that relates the input binary data of
a 2x2 matrix corresponding to 2 pixels in the main
scan directions and 2 input scan lines to the output
multi-level data of the "n" x "n" matrix
corresponding to "n" pixels in the main scan
directions and "n" output scan lines.

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37. The image resolution conversion circuit
15 as claimed in claim 35, wherein

 said data transform unit divides the "n" x
"n" matrix with the middle pixel array and the middle
scan line into four " $(n-1)/2$ " x " $(n-1)/2$ " sub-
matrixes, and

20 determines the output multi-level data of
the four " $(n-1)/2$ " x " $(n-1)/2$ " sub-matrixes based on
the corresponding respective input binary data;

 the output multi-level data of the upper
" $(n-1)/2$ " items and the output multi-level data of
25 the lower " $(n-1)/2$ " items in the middle pixel array

are based on 2 upper items and 2 lower items,
respectively, in the 2x2 matrix;

the output multi-level data of the left
"(n-1)/2" items and the output multi-level data of
5 the right "(n-1)/2" items in the middle scan line are
based on 2 left items and 2 right items, respectively,
in the 2x2 matrix; and

the output multi-level data of the cross
point of the middle pixel array and the middle scan
10 line are based on 4 items in the 2x2 matrix.

15 38. The image resolution conversion circuit
as claimed in claim 37,

wherein the data transform unit, when
determining the output multi-level data of the middle
pixel array based on the 2x2 matrix, shifts the phase
20 of the output multi-level data so that a pulse of the
light beam is shifted in the main scan directions
toward a pixel that is turned on.